Space Weather Technical Forecast

Issued on Wednesday, 29 March 2023 at 12:03 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of reaching G1/Minor Storm from late Day 2 (30th) into Days 3 and 4 (31st March and 1st April). Active electron fluence expected to continue into Day 2 (30th). Chance of isolated Moderate or stronger flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has reached High levels over the past 24 hours, following an X1.2 flare from AR3256 at 29/0233UTC.

There are currently seven numbered sunspot regions on the visible disc. AR3256 in the southwest remains the largest and most magnetically complex region, although showing some decay in the trailer portion. AR3263 and AR3265, both located in the northwest quadrant, are also showing some minor decay within their intermediate spot regions.The other active regions appear stable and magnetically simple, with only minor fluctuations in areal extent. There are three small unnumbered potential spot regions on the disc, two towards the east limb, the other just west of central disc. There are also signs of some minor pores emerging from plage regions close to the east limb, which will continue to be monitored for any new spots developing.

A CME was observed in coronagraph imagery leaving the west limb just prior to the X1 flare from AR3256, with a further CME following the flare. Both are modest in speed, and modelling results confirm they are clearly directed ahead of the Earth orbit.

Solar Wind / Geomagnetic Activity: The solar wind, as measured at L1 by ACE, was mostly at background levels, with speeds ranging between 350 and 450km/s. Density was below average. The IMF (Bt) was mostly weak between 5-9nT throughout the period, with the north-south component (Bz) also weak, varying between +5/-5nT. The net result of the above solar wind measures was for mostly Quiet (Kp 0-2) geomagnetic activity.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 remained at Background levels.

The high energy electron flux (greater than 2MeV) measured at GOES16 was at Moderate to High levels, with a peak of 3220 pfu observed at 29/1100 UTC. The associated 24-hour fluence has risen gently, and is now just above the Active (1e8 integrated pfu) threshold, with 1.11e8 integrated pfu observed at 29/0900UTC. At 29/0001 UTC the observed fluence was 8.21e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be predominantly Low, but with a Chance of further isolated M-class or stronger flares, most likely from AR3256 in the southwest.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs currently feature in the forecast. Solar winds are expected to remain at slow-ambient levels until the next coronal hole CH88/- becomes geoeffective, possibly arriving late on day 2 (30th), and continuing into days 3 and 4

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(31st March and 1st April). Initially Quiet (Kp 0-2) with slight chance of Unsettled interval (Kp 3) during day 1 (29th) and into day 2 (30th). Later on day 2 (30th) and into days 3 and 4 (31st March to 1st April), we are likely to see the arrival of a CIR ahead of the fast wind from CH88/-. Geomagnetic activity is likely to increase to Unsettled with Active intervals with a Chance of G1/Minor geomagnetic storms.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is expected to remain at Background levels, but with a Slight Chance of reaching S1 or greater, should any significant flares occur.

The high energy (greater than 2 MeV) electron flux is currently Moderate to High and is likely to continue at these levels through days 1 and 2 (29th and 30th), before reducing. The associated 24-hour fluence is expected to continue at Active levels into day 2 (30th), probably then easing by day 3 (31st) as the next HSS from CH88/- reaches Earth.

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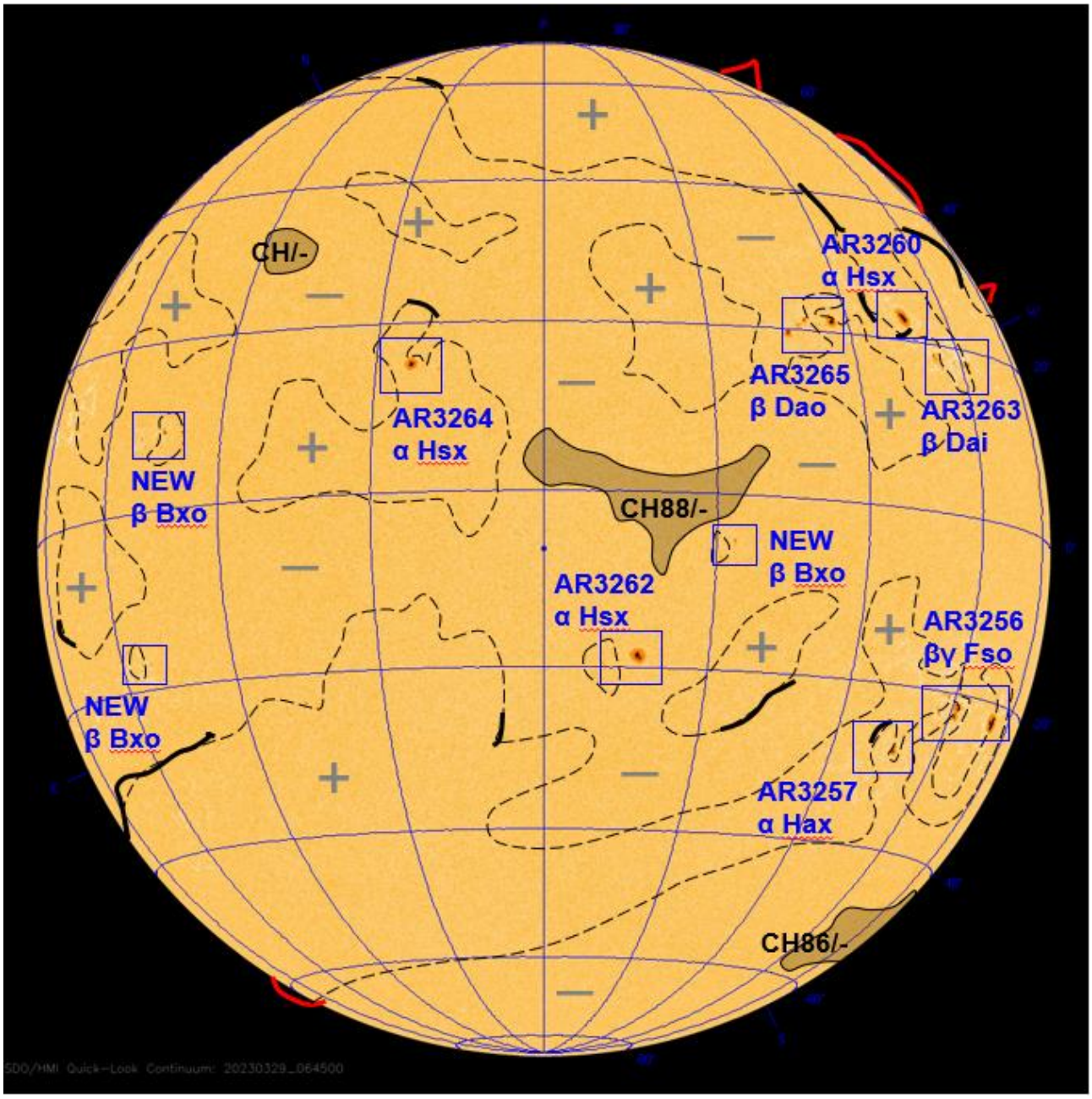
Figure 1. Solar Analysis Valid 29/0700 UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME was observed in coronagraph imagery leaving the west limb just prior to the X1 flare from AR3256, with a further CME following the flare. Both are modest in speed, and modelling results confirm they are clearly directed ahead of the Earth orbit.

Solar winds are currently at slow-ambient levels, which are expected to remain at this level during day 1 (29th) and into day 2 (30th). The next coronal hole expected to impact Earth is CH88/-. This appears slightly further west than the previous rotation so it's possible we may see its HSS and possibly CIR late on day 2 (30th), before entering into the HSS on day 3 (31st), with speeds likely to reach up to 500-550km/s.

Quiet to Unsettled (Kp 0-3) geomagnetic activity is expected on day 1 (29th) and into day 2 (30th). Later on day 2 (30th) and into day 3 (31st), we are likely to see a CIR arrive ahead of the HSS from CH88/-, which will increase geomagnetic activity to Unsettled (Kp 3) with Active (Kp 4) intervals, and a Chance of G1/Minor (Kp 5) geomagnetic storms. The effects of the HSS from CH88 are likely to continue through day 4 (April 1st).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	30	40	40
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

None expected.

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Radio Blackouts - X-Ray Flares:

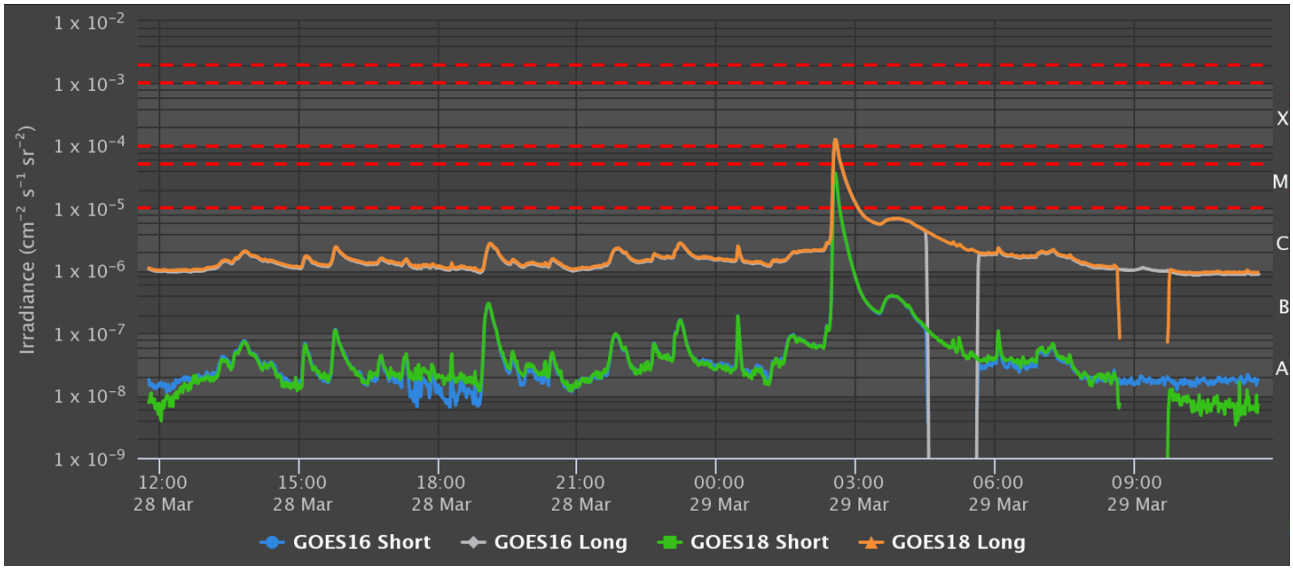
Solar activity has reached High levels over the past 24 hours, following an X1.2 flare from AR3256 at 29/0233UTC.

There are currently seven sunspot regions on the visible disc. AR3256 in the southwest remains the largest and most magnetically complex region, continuing to evolve in the trailer portion. AR3263 and AR3265, both located in the northwest quadrant, have also shown some growth within their intermediate spot regions.The other active regions appear stable and magnetically simple, with only minor fluctuations in areal extent.

Solar activity is likely to be predominantly Low, but with a Chance of further isolated M-class or stronger flares, most likely from AR3256.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	30	30	30	30
Very Active	R3 to R5 X Class	Yes	5	5	1	1

Figure 2: GOES X-ray flares



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Solar Radiation Storms - (High Energy Protons):

High energy proton flux (greater than 10MeV), as observed by GOES16 is currently at Background levels.

Proton flux is most likely to remain at Background levels, with a slight chance of reaching S1 or greater should any larger flares or significant CMEs occur.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux is at Moderate to High levels and is likely to continue at these levels through days 1 and 2 (29th and 30th). The anticipated HSS arrival from CH88/- is then likely to re-distribute electrons, with a reduction in electron flux levels expected.

The 24-hour integrated electron fluence has now risen above the Active threshold and is expected to continue at Active levels into day 2 (30th). However, as described above this should then reduce by days 3 and 4 (March 31st and 1st April) as Earth enters the High Speed Stream (HSS) from CH88/-. REFM trends are considered reasonable, although the forecast data values are lower confidence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	90	40	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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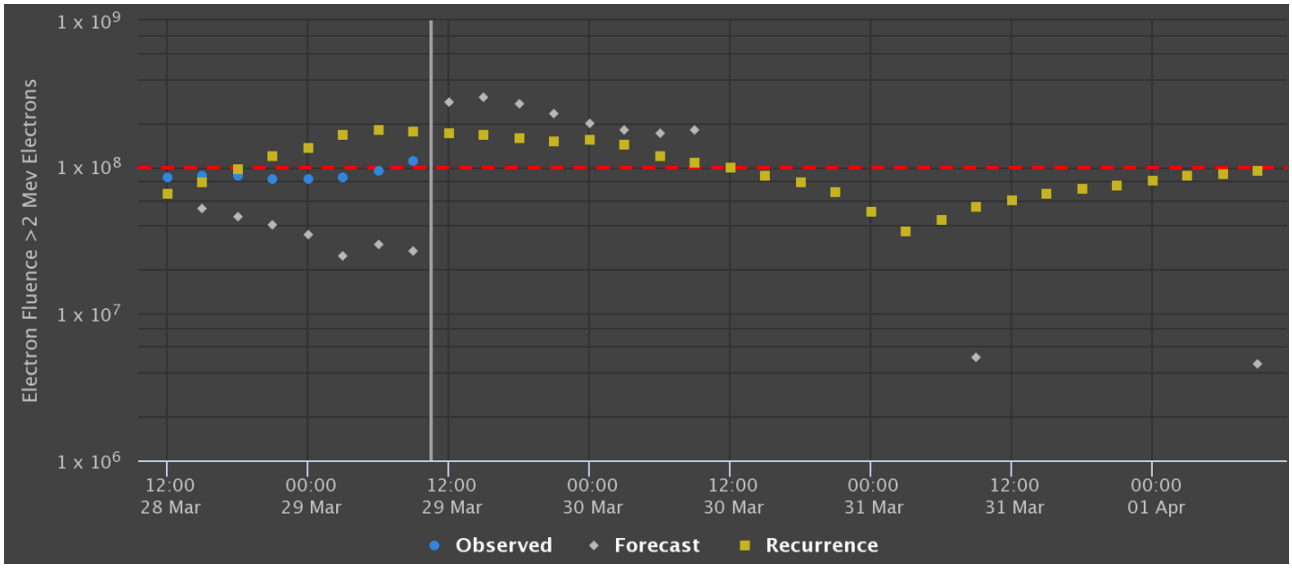
Figure 3: MOSWOC REFM latest observations and forecast



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